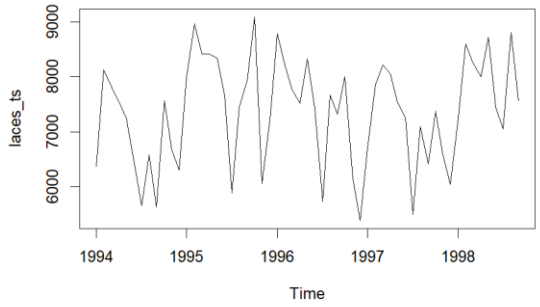
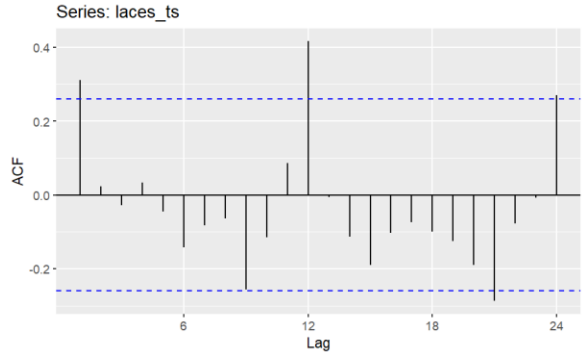
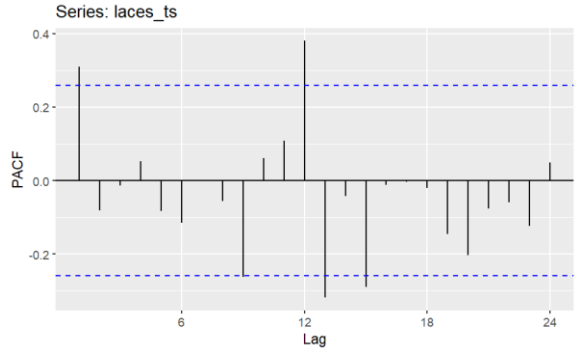
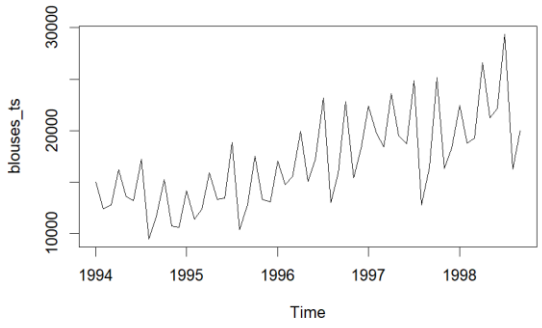
1. Time Series Situation
    a. Laces

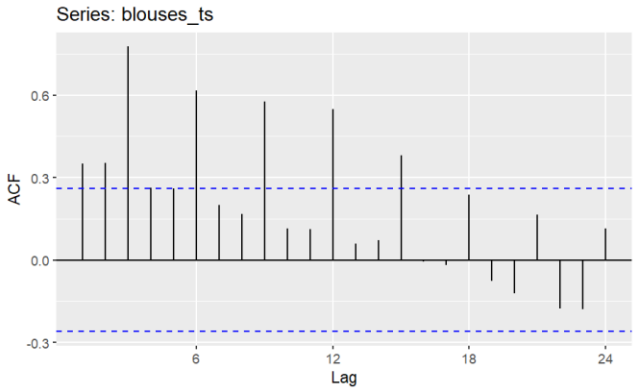


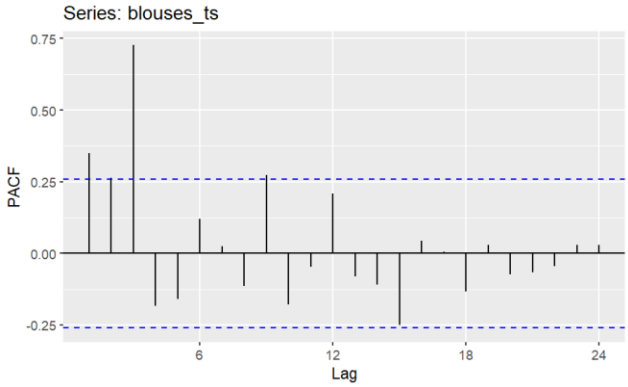




    b. Blouses



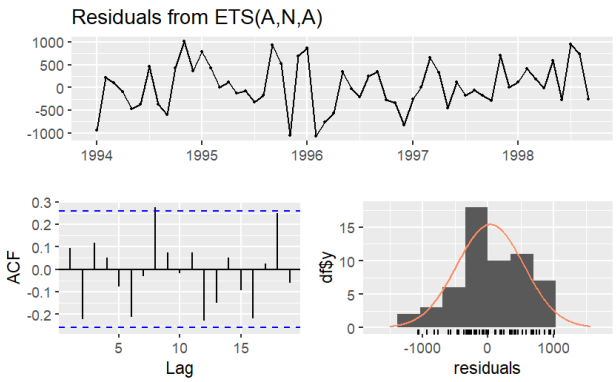


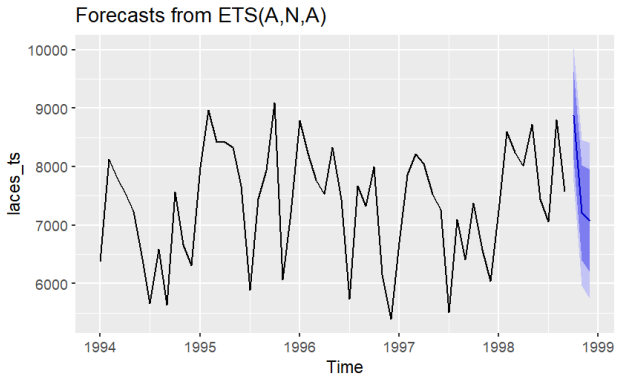


2. All models tried.
    a. Laces
        i. Seasonal Exponential Smoothing

The plot of the time series for Laces shows seasonality and no trend. Therefore, Seasonal Exponential Smoothing is tried first.

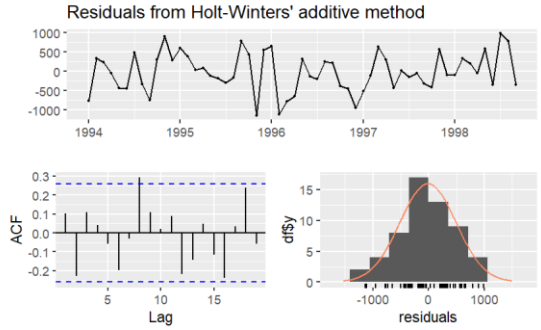
```
ETS(A,N,A)

Call:
 ets(y = laces_ts, model = "ZNZ")

  Smoothing parameters:
    alpha = 0.4248
    gamma = 1e-04

  Initial states:
    l = 7296.6637
    s = -1089.364 -945.9041 717.3814 -440.9268 112.9359 -1447.159
          54.9683 714.09 594.5541 710.5758 1010.943 7.9062

  sigma:  584.3131

     AIC      AICc       BIC
970.6182  982.3255 1001.2640

Training set error measures:
                    ME     RMSE      MAE       MPE     MAPE      MASE
Training set 35.56987 507.5075 409.3058 0.1185299 5.693469 0.527849
                    ACF1
Training set 0.09405117
```

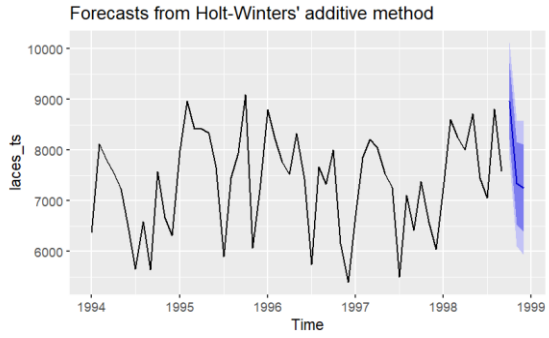




ii. Holt Winters Additive

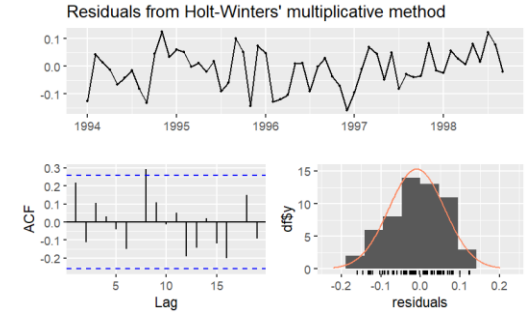
```
Model Information:
Holt-Winters' additive method

Call:
 hw(y = laces_ts, h = 3, seasonal = "additive")

  Smoothing parameters:
    alpha = 0.3929
    beta  = 1e-04
    gamma = 9e-04

  Initial states:
    l = 6943.8631
    b = 27.827
    s = -1063.638 -938.7904 706.2959 -452.7083 -10.9663 -1538.296
           78.5392 670.2344 605.3528 705.8103 1079.777 158.3902

  sigma:  589.4601

      AIC      AICc       BIC
 972.9032  988.5955 1007.6351

Error measures:
                    ME     RMSE      MAE        MPE     MAPE
Training set -13.24146 499.9297 412.251 -0.5648495 5.768398
                   MASE       ACF1
```

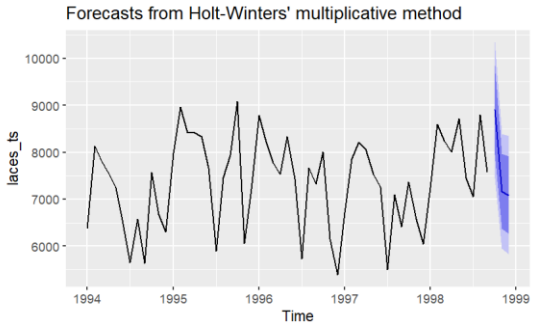




iii. Holt Winters Multiple

```
Model Information:
Holt-Winters' multiplicative method

Call:
 hw(y = laces_ts, h = 3, seasonal = "multiplicative")

  Smoothing parameters:
    alpha = 0.3026
    beta  = 0.0073
    gamma = 1e-04

  Initial states:
    l = 6962.9906
    b = 70.2565
    s = 0.8548 0.869 1.084 0.9394 1.0209 0.8189
           0.9633 1.0904 1.0802 1.1028 1.1404 1.0359

  sigma:  0.0829

     AIC     AICc      BIC
977.3845  993.0768 1012.1164

Error measures:
                     ME    RMSE      MAE       MPE     MAPE      MASE
Training set -72.27164 513.761 419.5037 -1.486683 5.940346 0.5410004
                   ACF1
Training set 0.2311113
```



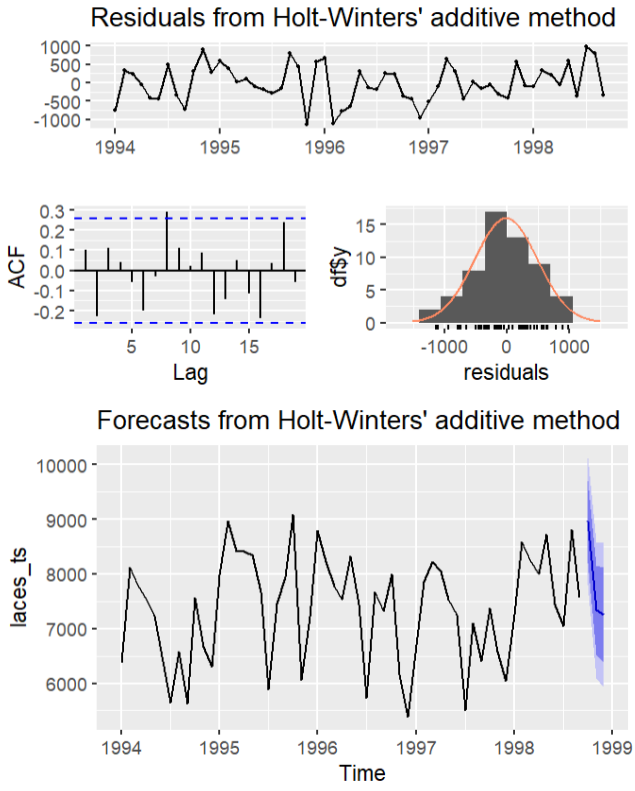


b. Blouses

i. Holt Winters Additive

The plot of the time series shows both trend and seasonality. Therefore, Holt-Winters should be tried.

```
Model Information:
Holt-Winters' additive method

Call:
 hw(y = laces_ts, h = 3, seasonal = "additive")

  Smoothing parameters:
    alpha = 0.3929
    beta  = 1e-04
    gamma = 9e-04

  Initial states:
    l = 6943.8631
    b = 27.827
    s = -1063.638 -938.7904 706.2959 -452.7083 -10.9663 -1538.296
          78.5392 670.2344 605.3528 705.8103 1079.777 158.3902

  sigma:  589.4601

     AIC     AICc      BIC
972.9032 988.5955 1007.6351

Error measures:
                    ME     RMSE      MAE        MPE     MAPE      MASE      ACF1
Training set -13.24146 499.9297 412.251 -0.5648495 5.768398 0.5316471 0.1016371
```



3. Best model
    a. Justification for the final model.
        i. Laces
            1. Each model's evaluation metrics

	RMSE	MAPE
SES	507.5075	5.693469
HWM	513.761	5.940346
HWA	499.9297	5.768398
Auto.ARIMA	606.7496	5.88871

            2. Comparing predicted values and actual values

	RMSE	MAPE
SES	840.8312	11.60003
HWA	828.4357	11.38986
Auto.ARIMA	933.9091	8.324494

3. Discussion

The table of the evaluation metrics of each model shows that HWA has a smaller RMSE and SES has a smaller MAPE. And the table comparing predicted values and actual values shows that HWA has both lower RMSE and MAPE. Therefore, for the data of LACES, the Holt-Winters' additive method model is chosen.

ii. Blouses

1. Each model's evaluation metrics

	RMSE	MAPE
HWA	1062.155	5.022268
HWM	902.73	4.654127
Auto.ARIMA	1106.891	4.280318

2. Comparing predicted values and actual values

	RMSE	MAPE
HWA	2305.212	8.528701
HWM	2572.436	8.836726
Auto.ARIMA	2181.074	6.428584

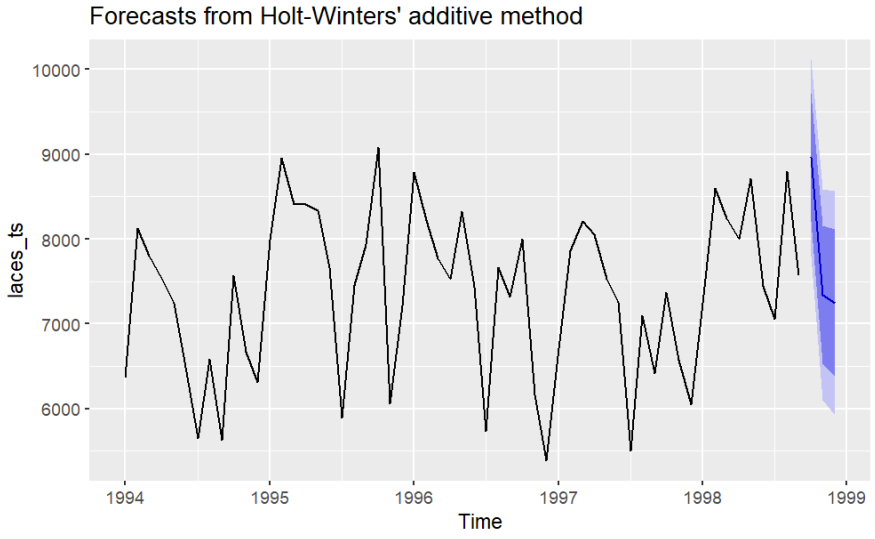
3. Discussion

The table for each model shows that HWM has both smaller RMSE and MAPE, while another table shows that HWA has both smaller RMSE and MAPE. This situation makes the decision of the final model difficult. However, because only three following actual values are provided to check the accuracy, there is possible bias in the short term. Therefore, Holt-Winters' multiplicative method is selected, because it has lower RMSE and MAPE for model evaluation.

b. Forecast values and plots.

i. Laces - Holt-Winters' additive method

	Point Forecast <dbl>	Lo 80 <dbl>	Hi 80 <dbl>	Lo 95 <dbl>	Hi 95 <dbl>
Oct 1998	8961.782	8206.358	9717.205	7806.461	10117.102
Nov 1998	7344.387	6532.711	8156.062	6103.036	8585.737
Dec 1998	7247.217	6382.918	8111.517	5925.385	8569.050



ii. Blouses - Holt-Winters' multiplicative method

	Point Forecast <dbl>	Lo 80 <dbl>	Hi 80 <dbl>	Lo 95 <dbl>	Hi 95 <dbl>
Oct 1998	27534.00	25252.26	29815.75	24044.37	31023.63
Nov 1998	19043.85	17432.10	20655.60	16578.89	21508.81
Dec 1998	20905.34	19100.44	22710.24	18144.99	23665.70